AFRRI TN70-1
JULY 1970

AFRRI
TECHNICAL NOTE

CLOSED CIRCUIT TELEVISION APPLICATIONS IN REACTOR RADIATION BIOLOGY RESEARCH

ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE
Defense Atomic Support Agency
Bethesda, Maryland

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CLOSED CIRCUIT TELEVISION APPLICATIONS IN REACTOR RADIATION BIOLOGY RESEARCH

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ACKNOWLEDGMENT

The author expresses his gratitude to the other members of the Television Division, R. S. Kite and K. R. Richardson, and the members of the AFRRI staff that have aided in making the television system possible.

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ABSTRACT

Closed circuit television provides the investigative staff with visual and aural communications in research using the AFRRI-TRIGA reactor. This report describes the television system in its applications to research support and documentation, and in reactor operations safety.

I. INTRODUCTION

Biological experiments conducted in a radiation environment preclude the presence of the investigator for observations of specimens. These observations can be made via closed circuit television. For this purpose the Armed Forces Radiobiology Research Institute (AFRRI) employs an extensive monochrome television system in support of its research and radiation source operations efforts. The television system is designed to meet numerous and variable requirements depending upon the experiment in progress.

This report describes the television equipment and its applications associated with reactor radiation biology research exposures and the operations of the AFRRI-TRIGA reactor.

II. EQUIPMENT

The television system serves the entire Institute. Television cameras and monitors are located throughout AFRRI, while a centralized master control facility provides the control, signal processing, signal distribution and recording capabilities required in support of the research and AFRRI-TRIGA reactor operations.

Television cameras are located: (a) in the specimen training areas, (b) in the exposure rooms, and (c) above the reactor. RCA PK-302 transistorized vidicon cameras are used in the training areas, whereas RCA TK-202 tube type vidicon cameras are used in the areas directly associated with the reactor. Tube type cameras are used in the radiation environments because they are less susceptible to radiation damage than transistorized types.

All camera locations are equipped for remotely controlled pan-and-tilt units and zoom lenses. Pelco dc powered pan-and-tilt units are used throughout the television system, permitting camera orientation movements, vertically and horizontally, from a fixed camera stand location. Standard camera tripods are used where possible. However, in radiation field areas nonmetallic stands are used. These stands are manufactured from wood or Lucite, and permit adjustable working heights. The nonmetallic stands do not become radioactive when exposed to reactor radiations and, therefore, obviate the production of significant radioactive by-products, thus reducing the radiation hazard to the persons handling this equipment.

Wollensak nonbrowning zoom and fixed focal length lenses are used. The selection of lenses is determined by the field of view required, or the variations thereof. The depth of field for each lens is minimal, i.e., the lenses are operated at the smallest f-stop, thus reducing both the light requirement and the heat as produced by the lighting equipment. Remotely controlled focus of the cameras and zoom lenses permits this type of operation, depth of field not being a critical factor.

CONRAC and RCA monitors are located: (a) in the laboratories, (b) in the exposure preparation area, and (c) in the control rooms. Several monitor installations are equipped with video signal switching devices, or switchers. These areas are involved in several simultaneous operations that require random selectivity of the visual information from the experiments in progress.

The centralized master control facility provides the remaining equipment necessary for the operation of the system. Television monitors, special effects

generators, video switching and distribution equipment, remote controls and audio controls (Figure 1) comprise the major portion of this equipment. The video tape recorders and digital clocks are also located here.

Television monitors provide the system operators with visual control over all video signal sources. Figure 1 illustrates numerous monitors installed in the centralized control facility for this purpose. Each camera can be monitored for setup and control of picture content. Processed signals are also monitored, i.e., those signals being distributed throughout the Institute or being video tape recorded. Two Ball Brothers Research Corporation Mark VII-A special effects generators are used to split the picture format into two or more areas. Figure 2 is an example of two video signals within a split picture. The animal and telemetry, superimposed into one video signal, occupy the upper portion and the elapsed time is in the lower portion. Two animals could occupy the upper portion, splitting that portion of the picture vertically, with the time data inserted in the lower portion, similar to Figure 2.

The switching and distribution equipment permit signal routing as required. The switching equipment (AFRRI constructed) permits selection of the signal(s) and the RCA TA-33 and TA-32 video distribution amplifiers provide the required number of signal paths for processing, distribution, monitoring and recording. Visual control over the amplitude of the electrical parameters which make up the video signal is accomplished by a Tektronix RM-527 waveform monitor.

Remote controls for the cameras, pan-and-tilt units and zoom lenses are located in the control console, as are the primary audio controls. Bogen microphone mixers and amplifiers provide the amplification needed of the audio

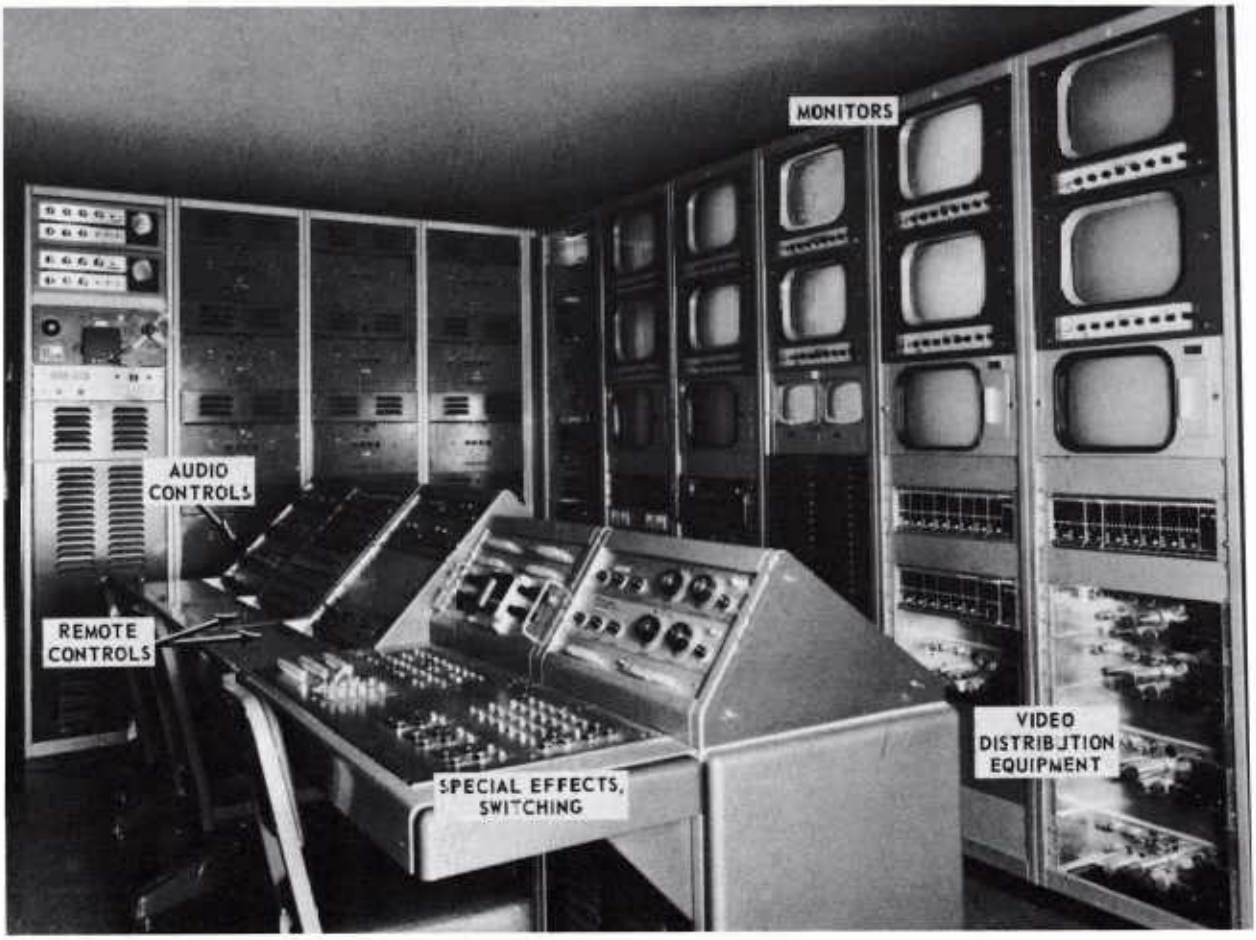

Figure 1. Centralized television control facility

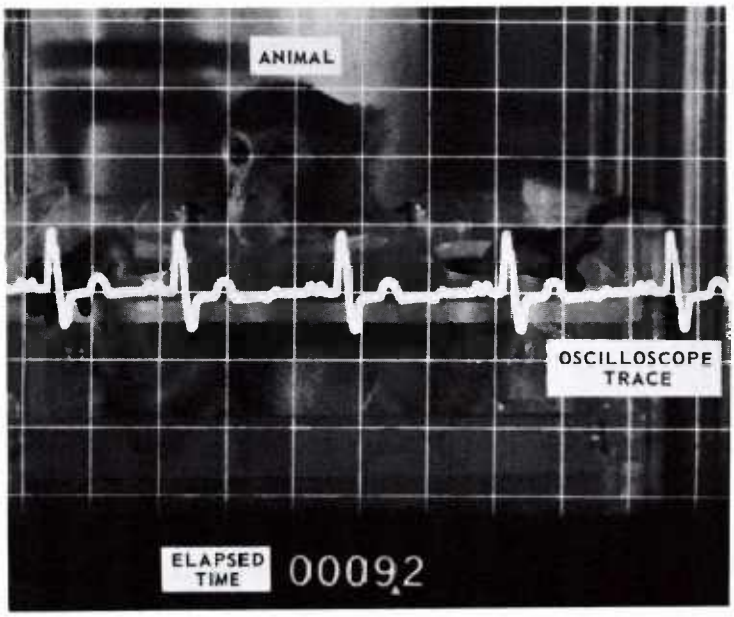

Figure 2. Composite view of animal, telemetry, and elapsed time

(exposure-training area sounds and investigator narrations) signals for monitoring and recording.

Two RCA TR-4 video tape recorders (VTR's) provide for simultaneous recording of two experiments, reviewing of experimental data, editing of previously recorded data, or the playback of video tapes from outside sources. One of the VTR's is equipped with electronic splicing which alleviates the need for physical splicing of the video tape. Each VTR is equipped for two audio channels, both record and playback.

Cameras located in the television control room provide the necessary facilities for telecasting elapsed time information and other data. Time information is telecast by viewing the time readout device with an RCA PK-310 transistorized television camera. The clock starts at the time irradiation commences, whether the irradiation is pulse mode or steady-state. Other data, e.g., physiological information, are transmitted to the control room by cable, displayed on an oscilloscope, and scanned by a television camera. This information becomes part of the composite visual presentation (Figure 2).

Electronic control over the television system is centrally located. However, various other parameters of an experiment in progress are located throughout the Institute. Therefore, intercommunications (headsets) are required, permitting aural coordination of all phases of the experiment between the investigator, the reactor operator, and the television staff.

III. APPLICATIONS

The closed circuit television system provides the investigative staff of the AFRRI with a media for observing (a) biological specimens in training or undergoing irradiations, (b) reactor operations, and (c) other televised data in real time, i.e., as the events take place. Video tape recordings and tape-to-film transfers[1] provide the capability of documentation of an experiment, the delayed reviewing of this experiment and the availability of a permanent record.

Biological specimens required to perform various tasks are trained in isolated areas external to those associated with the reactor. These tasks include, in part, shock avoidance problems in traversing a multichambered maze by an unfettered animal[3-6] and visual pattern discrimination by a fettered animal.[2] Continual observations, via television, from the training area to the program control area are required to establish preirradiation performance base lines. Postirradiation performance data are collected by duplicating the training environment in one of the reactor exposure rooms, and monitoring by television.

Single and multiple animal[7] (Figure 3) irradiations require visual observations to determine the apparent effects[10] of irradiation. Convulsions, vomiting, estimates of time of incapacitation and the visible physical condition of the animal(s) provide valuable data to the investigator, data which cannot be collected by any other means.[8,9] Position of the animal(s) is also important. It is necessary for the investigator to know the orientation of the biological specimens in relation to the reactor[11] at the time of irradiation; and during bilateral exposures, that all animals are turned at the same time and remain in the new position.

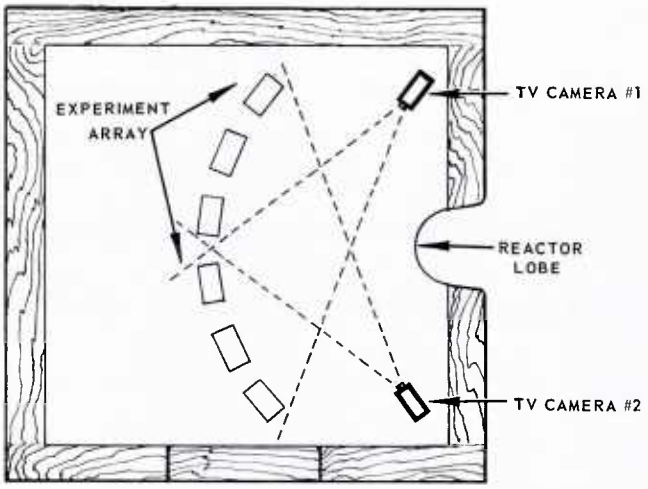

Figure 3. Multiple animal array
televised by two cameras

Physiological data and elapsed time represent other information that are telecast as part of the research program requirements. Physiological data, hardwire and telemetry, are transmitted from the exposure room to the laboratory and the television control room. Telecasts of elapsed time since start of exposure are generated in the television control room. These signals are incorporated into the visual presentation of the experiment to the investigator as part of his experiment-in-progress television coverage.

Animals that have escaped their specific experimental environment and are free to roam the reactor exposure room must be located by television prior to anyone's entering the room to restrain them.

In addition to the experiments in progress, the AFRRI-TRIGA reactor is constantly monitored. This application fulfills a safety need, i.e., as a visual backup for the reactor interlocks and instrumentation. The reactor core must traverse

from one end of the pool to the other. During operations, it must be immediately adjacent to the room in which the exposure is to take place and at the opposite end for the safety interlocks to allow that room to be entered. Two lead shielding doors must be opened prior to the reactor core travel. The camera allows the reactor operators constant visual surveillance of the location of the reactor (Figure 4), the position of the lead doors, and the pool itself to determine that the latter does not contain foreign objects detrimental to the reactor operations.

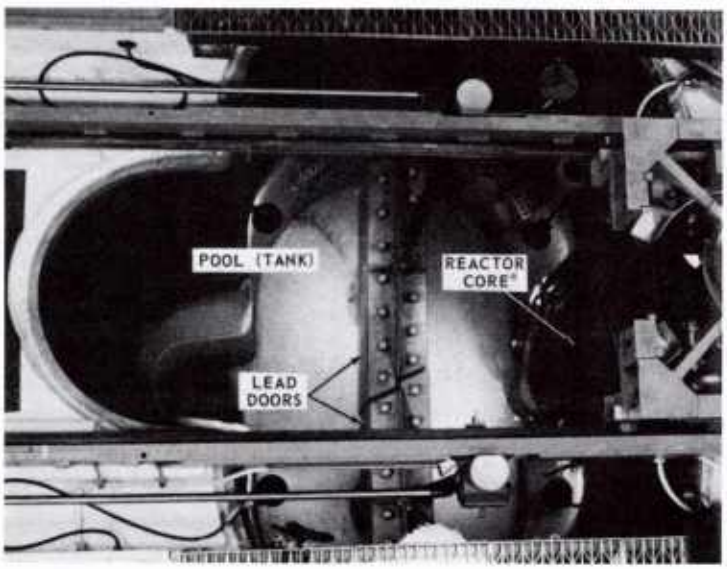

Figure 4. Camera view of the AFRRI-TRIGA reactor and pool

IV. SUMMARY

Through the utilization of the television facilities available, the radiation biology researcher is able to visually monitor his experiment in progress, narrate the events in real time, and maintain contact with others associated with his experiment. By replaying the documented data, a review of all reactor exposures pertaining to a particular experiment is possible.

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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Armed Forces Radiobiology Research Institute
Defense Atomic Support Agency
Bethesda, Maryland 20014

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP
N/A

3. REPORT TITLE
CLOSED CIRCUIT TELEVISION APPLICATIONS IN REACTOR RADIATION BIOLOGY RESEARCH

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*
D. R. Millbranth

6. REPORT DATE
July 1970

7a. TOTAL NO. OF PAGES
14

7b. NO. OF REFS
11

8a. CONTRACT OR GRANT NO.

b. PROJECT NO. NWER XAXM

c. Task and Subtask A 904

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
AFRRI TN70-1

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Director
Defense Atomic Support Agency
Washington, D. C. 20305

13. ABSTRACT

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DD FORM 1 NOV 65 1473 (PAGE 1)
S/N 0101-807-6801

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT